FLAVIIR

INNOVATION THROUGH PARTNERSHIP

THE FLAVIIR PROJECT

The project

The FLAVIIR project is being undertaken by a consortium including BAE Systems and EPSRC. Liverpool University Laser Group is currently tasked with the generation of desirable sensors and conductive paths which can be embedded within CFC composites and utilised within a demonstrator maintenance-free Unmanned Aerial Vehicle (UAV) to be produced as the end result of the FLAVIIR programme. This task initially requires conductive paths and sensors to be deposited on plane surfaces but may have to be extended to the ability to deposit desired components on curved surfaces as the project advances. ULIV-FLAVIIR will also have to tailor the application of suitable technologies to processes and materials being used by other groups in the consortium. As a result multiple technologies are being assessed for the task. It is anticipated that more than one 'direct writing' process may have to be employed.

Direct Write

The term Direct Write (DW) encompasses a range of technologies which can be used to produce 2D and/or 3D structures on pre-existing substrates. Within this definition lie additive processes, surface modification processes and selective removal processes. DW systems may employ more than one of these process methods to produce a final functional component of the desired characteristics and are usually defined as employing a computer-controlled stage to produce accurate structures.

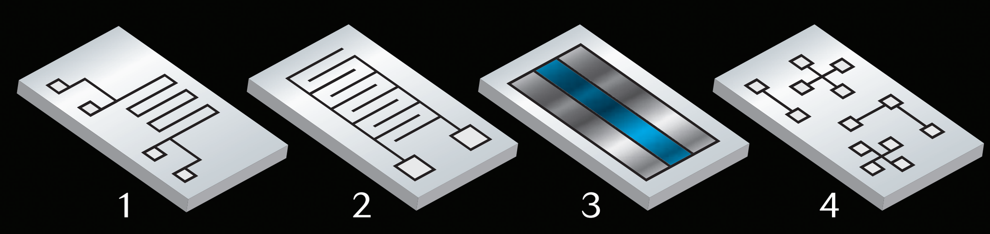
Sensors

There are several forms of sensors which are suitable for deposition techniques. Generally, they must include insulating layers, a sensing layer, metallic interconnects for energy and data transfer, and a protective surrounding layer. Thin film sensors also offer small mass and profile, low current usage and the possibility of the production of increased complexity with little additional effort. Sensors will be constructed on carbon fibre sheets which then go on to form the composite skin of the UAV. The sensors have to be deposited prior to the carbon fibre lamination stage so that they can be embedded within the structure.

The sensor must be positioned in the most advantageous area, hence alignment and embedded depth become the most critical factors. It is anticipated that sensors will be distributed through areas of interest in the composite and hence will have to have a small footprint to avoid delamination of the composite layers.

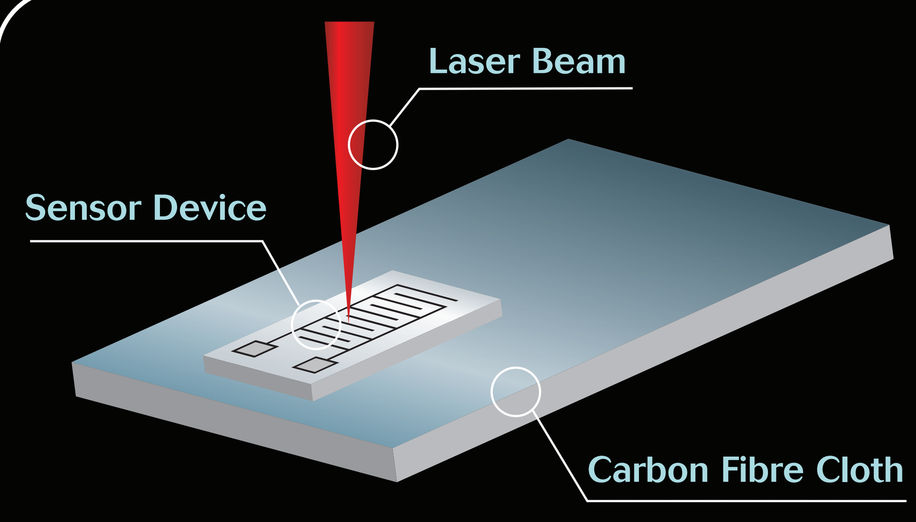
Necessary sensors

- Temperature[1]
- Humidity[2]
- Pressure[3]
- Strain[4]



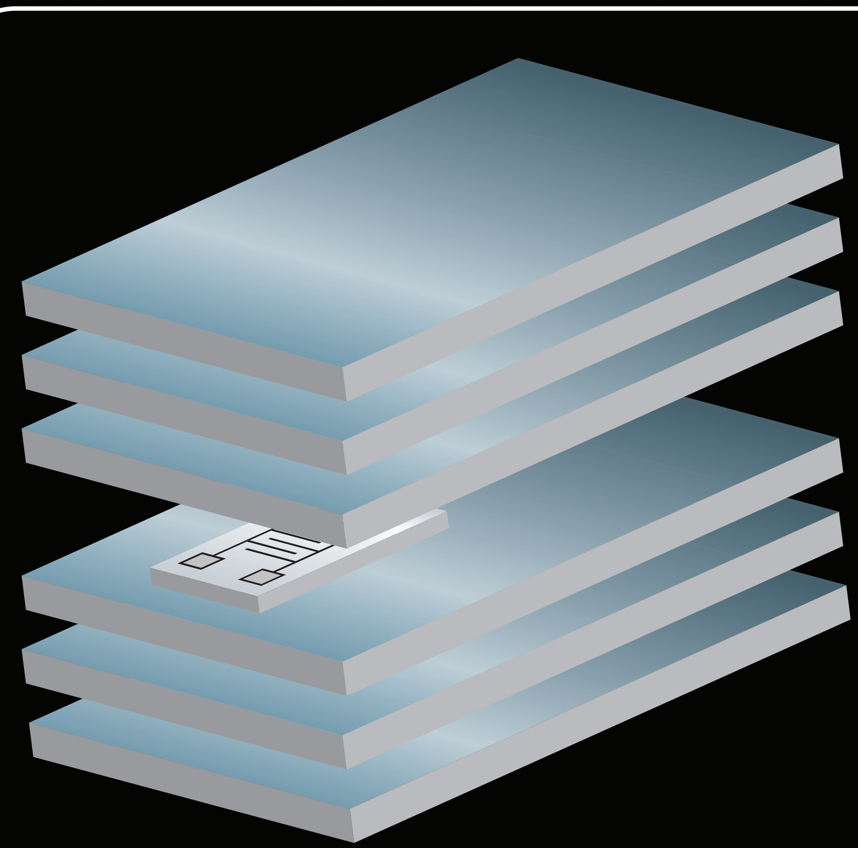
Using lasers to make the sensors

Lasers can be used to create small features on a suitable substrate by using additive, ablative or reactive chemical methods. For fine (<100 micron) features, the shorter wavelength lasers are most commonly used.



Stage 1. Use a laser to deposit or machine a sensor on the surface of the Carbon Fibre Composite layer

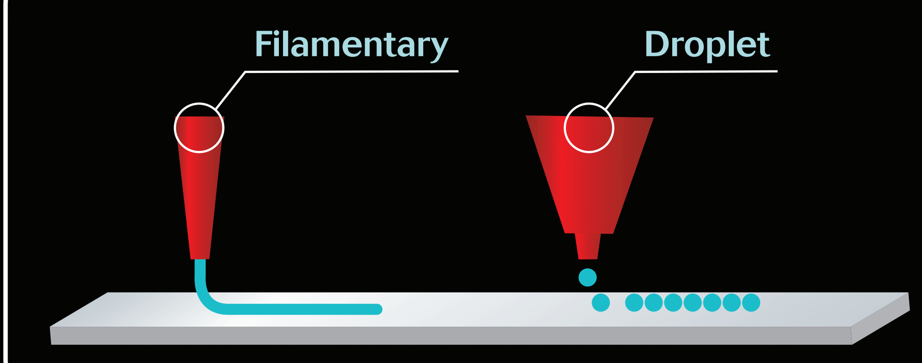
These include excimer (193 and 248nm), frequency doubled or frequency tripled Nd:YAG and high beam quality short-pulse lasers (nanosecond pulsed or lower). With additive processes, lasers can be used to generate 2 and 3-D structures at resolutions of a few tens of microns whereas laser machining or ablative processes can remove pre-placed materials in defined patterns to a feature resolution of less than half a micron. With some processes, laser machining is used as a final step to remove unwanted material which has been deposited in order to refine the deposited feature to the required resolution/dimension.



Stage 2. Incorporate the sensor layor into the laminate lay up

Inkjet technologies

Lasers are not the only technology that will be employed. It is highly likely that some inkjet technologies will also be used. Inkjet technologies for the deposition of sensors have evolved from printing technologies and can create multilayer systems by the deposition of inks containing colloids, nanoparticles or organic compounds (including viable cells). Commercial products in this field include NSCRYPT and M3D. Inkjet technologies can be separated into two broad classes based on how the ink is delivered ie. whether it is delivered in a continuous stream (filamentary approach) or in a series of discrete droplets.



Metallic paths can be printed by using a metal precursor which can be subsequently treated to convert it to the pure metal. Silver and copper electrodes have been printed using this technique. Ceramics can also be inkjet printed either directly with particles in solution (to be subsequently sintered) or by printing a binder on pre-placed ceramic particles.

THE UNIVERSITY of LIVERPOOL

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